

## **REMARKS**

In response to the above Office Action, claim 1 has been amended to include the subject matter of claim 2, claim 5 has been amended to include the subject matter of claim 6, claim 10 has been amended to include the subject matter of claim 11 and claims 2, 6, and 11 have been cancelled. Appropriate amendments have been made to the dependent claims to reflect these amendments to the independent claims and to avoid improper multiple dependency. Reconsideration of the objections and rejections in light of the amended claims and the following is requested.

In the Office Action, the Examiner rejected claims 1-14 under 35 U.S.C. § 102(b) for being anticipated by U.S. Patent No. 5,798,433 to Schmidt et al., (hereafter Schmidt).

The inventions of claims 1, 3, and 4 relate to an improved poly(trimethylene terephthalate) (PTT) having a high intrinsic viscosity and being excellent in shade ( $L^*$  value) and whiteness ( $b^*$  value) and melt stability. The inventions of claims 5, 7-10, and 12 relate to a process for producing the improved poly(trimethylene terephthalate) by carrying out a specific polycondensation in molten state without the addition of a color-modifier. The inventions of claims 13 and 14 are article claims dependent on claims 1, 3, or 4 and claims 5 or 10, respectively.

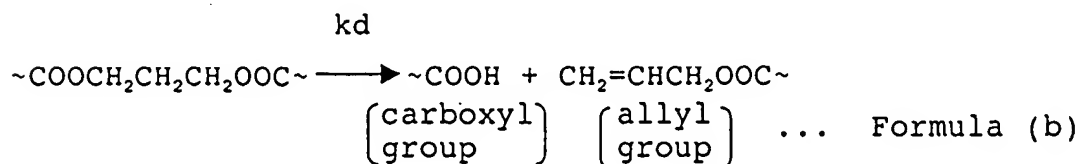
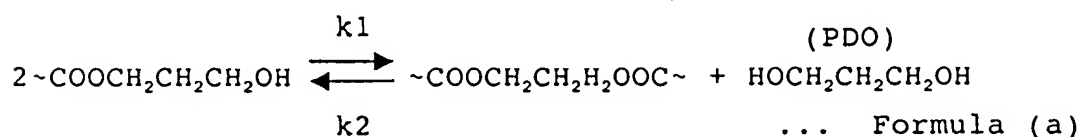
Poly(trimethylene terephthalate) based fibers have properties such as a surprising softness, drape ability, stretchability, low temperature dyeability, resistance to weathering and the like which properties polyamide fiber cannot provide. For this reason, development of poly(trimethylene terephthalate) based fiber, especially for use in clothing is very promising.

However, there are crucial problems in that (1) a poly(trimethylene terephthalate) having a high intrinsic viscosity is difficult to attain by melt polymerization alone due to the characteristic occurrence of leveling-off (peaking phenomenon) of intrinsic viscosity near an inherent viscosity of 0.8 dl/g, and (2) the occurrence of discoloration in the ultimate polymer (see the specification at page 2, lines 1 to 35).

Further problems lie in the properties of poly(trimethylene terephthalate), which affect the qualities of ultimate shaped articles such as fiber. Problems include (1) yellow-tinged color, (2) further yellowing discoloration of polymer in the melt spinning state, and (3) occurrence of a noticeable deterioration in polymerization degree (melt stability) during the melt spinning stage which brings about a failure of development of a desired strength (see the specification at page 3, lines 2 to 21).

The problems as discussed above must be overcome in the commercialization of PTT fiber.

The applicants paid attention to the following two reactions taking place during the polycondensation of PTT.



As a result, the applicants have found that the problems as discussed above can be solved by maintaining the following two criteria simultaneously (see the specification at page 3, line 20 to page 5, line 17).

(1) Balance of the terminal end groups between hydroxyl group, carboxyl group and allyl group present in the PTT polymer must be controlled throughout the melt polycondensation; and

(2) Efficient discharge of 1, 2-propanediol (PDO) to increase and obtain the desired viscosity of the polymer.

The PTT of the invention has a high intrinsic viscosity and excellent properties for making a textile fiber such as stability of color and melt stability.

Claim 1 relates to a PTT comprising 80% by weight or more of trimethylene terephthalate units based on the entire repeating units and satisfies the following conditions:

(1) the intrinsic viscosity is from 0.4 to 1.5 dl/g;

(2) the L\* value is 80 or more, and the b\* value is from -1 to 5; and

(3) 
$$\frac{[-OH]}{[-OH] + [-COOH] + [-CH_2CH=CH_2]} \times 100 \geq 40$$
 wherein [-OH], [-COOH] and [-CH<sub>2</sub>CH=CH<sub>2</sub>] represent a terminal hydroxyl group content, a terminal carboxyl group content and a terminal allyl group content of the PTT, respectively.

Claim 5 relates to a process for producing a PTT wherein terephthalic acid and/or its lower alcohol ester is reacted with 1,3-propanediol to form 1,3-propanediol ester of terephthalic acid and/or its oligomer, and then polycondensation reaction of the reactant is conducted to give a poly(trimethylene terephthalate) containing 80% by weight or more of trimethylene terephthalate units based on the entire repeating units,

the process comprising conducting the polycondensation reaction at a temperature in a range of from 235 to 270°C while the formula (1) is being satisfied and while formula (2) is maintained when an intrinsic viscosity for the polycondensation product reaches 0.5 dl/g or more:

$$[-OH] / ([-OH] + [-COOH] + [-CH_2CH=CH_2]) \times 100 \geq 40 \quad (1)$$

wherein  $[-OH]$ ,  $[-COOH]$  and  $[-CH_2CH=CH_2]$  represent a terminal hydroxyl group content, a terminal carboxyl group content and a terminal allyl group content of the PTT, respectively, and

$$S/V \geq 0.07 \text{ cm}^2/\text{g} \quad (2)$$

wherein S represents a total surface area ( $\text{cm}^2$ ) of the polycondensation product and V represents a weight (g) thereof.

Claim 10 is the process of claim 5 carried out in a continuous basis.

The PTT of claim 1 is excellent in color and does not create discoloration during the melt spinning stage. A fiber therefrom can be dyed or pigmented in a color excellent in brilliancy. Fiber therefrom can meet every need of color shade required in its applications to textiles. Further, a PTT of the present invention is able to have a high intrinsic viscosity and does not deteriorate in its polymerization degree during melt spinning stage. A fiber from the PTT has a high tenacity. Accordingly, a fabric therefrom has high tear strength as well as high burst strength superior in durability and, therefore, exhibits excellent use performances.

The PTT according to the present invention is an ideal PTT satisfying all requirements of the properties as material for making PTT fiber for textile use. The PTT

polymer also can be used as shaping material for forming shaped articles other than fiber such as a film.

The process of claim 5 for producing a PTT provides a process for obtaining the above-mentioned superior PTT by carrying out polycondensation reaction under melt polymerization system alone (with solid phase polymerization excluded). Further, the present polymer producing technology enables the present PTT to be obtained at 0.3 ton/batch in case of a batch system and 10 tons or more/day in case of a continuous large scale polymerization system. This contributes significantly to a reduction of the cost of producing PTT.

Condition (1) of claim 1 enables the PTT to make a fiber having excellent tenacity.

Condition (2) enables the PTT to produce a PTT fiber capable of providing a brilliant dyed color. If the  $L^*$  value is less than 80, the dyed fiber is dull in shade, and lacks brilliancy.

Condition (3) relates to melt stability of the PTT. With the X ([-OH] in a total of contents of terminal groups in the polymer) value greater than 40, the PTT polymer exhibits excellent melt stability. Mechanical properties of a fiber formed of a polymeric material are a reflection of its intrinsic viscosity; the greater the intrinsic viscosity, the greater the tensile strength of the fiber.

Figure A attached is a diagram showing X vs. melt stability (retention ratio of intrinsic viscosity) of PTT polymers described in the present Examples and Comparative Examples. As shown by Figure A, the retention ratio of intrinsic viscosity is critically reduced at a X value below 40. Figure A clearly shows that a PTT with a [-OH] ratio of

40 or more, i.e., the presence of terminal hydroxyl groups being rich relative to terminal carboxyl groups and allyl groups enhances melt stability.

The present PTT having excellent melt stability is hard to thermally decompose and occurrence of discoloration during melt spinning is hindered.

Some of the conditions of the claims are met by the PTT of Schmidt. However, the PTT polymers described in the Comparative Examples and Examples of Schmidt do not satisfy all of the conditions of the amended claims. For example, the polycondensation reactions of the Examples and Comparative Examples of Schmidt are not carried out under conditions satisfying (1) the claimed X value (terminal [-OH] group ratio (%) to the total terminal end groups in the polymer) of 40 or more.

In support of this, enclosed is a declaration of Dr. Jinichiro Kato, one of the inventors of this application, setting forth an experiment he conducted according to Example 6 of Schmidt. The Declaration is marked Exhibit A. With reference to the Table on page 3 of the declaration, it can be seen that the PTT polymer obtained according to Example 6 of Schmidt had a X value of only 35, which is less than the claimed value of 40 or more.

Dr. Kato also conducted an experiment according to Comparative Example 2 of Schmidt. The results of this experiment are set forth in the declaration marked Exhibit B. As shown in the Table on page 3 of this declaration, the PTT polymer obtained according to Comparative Example 2 of Schmidt had a X value of only 34, which is also less than the claimed value of 40 or more.

In contrast, see Table 1 on page 35 of the present application and the X values of the polymers of Examples 1-8 which are all above 40. Note also Comparative Examples 1 and 2 where the values were below 40.

In addition, it is submitted that the PTT polymers of Schmidt also do not satisfy condition (2) of amended claim 1. Again with reference to the declaration of Exhibit A, Dr. Kato determined that the PTT polymer of Example 6 had a L\* value of 76 which is outside the claimed range of 80 or more. With a value of L\* of less than 80, a polymer (fiber, shaped article) looks darkish or dull, and lacks brightness in color (whiteness). This is because in Example 6 of Schmidt the polycondensation is carried out in the presence of an antimony based catalyst. Similarly, L\* values of resultant PTT polymers in Examples 5 and 7 using an antimony based polycondensation catalyst, and Comparative Examples 3 and 4 of Schmidt would also be below 80. For this reason, fibers from these PTT polymers having a L\* value of less than 80 will not develop a color rich in brilliancy.

The L\* value of Comparative Example 2 of Schmidt of 84 (declaration of Exhibit B) is within the claimed range, but it is noted this is a Comparative Example and not one considered to be part of the invention of the reference for here an antimony based catalyst was not used.

In any event, it is submitted that because the PTT polymers of Schmidt do not have a X value of 40 or more as required by condition (3) of amended claim 1, it is submitted that claim 1 nor its dependent claims 3, 4, and 13 can be considered anticipated by this reference. Its withdrawal as a ground of rejection of these claims under §102 is therefore requested.

As noted above, the rich presence of terminal hydroxyl groups relative to the total of terminal end groups of the polymer (i.e., its X value) enhances melt stability of the polymer and thus all of the advantages that flow from it. Accordingly, it is submitted that the claimed PTT polymers can also not be considered obvious in view of the polymers of Schmidt.

With respect to independent process claims 5 and 10, both of these claims also require that the polycondensation reaction produce a product having a X value of 40 or more. In addition, they both require that the product have an S/V value of 0.07 or more where S is the total surface area in  $\text{cm}^2$  of the product and V is the weight in grams thereof.

The X value of the polymer has been discussed above and for this reason at least, it is submitted that process claims 5 and 10 and their dependent claims 7-9 and 12, respectively, cannot be considered anticipated by this reference.

The S/V value (Formula (2) in claims 5 and 10) is the state of the thin film of the polycondensate in the polycondensation reaction vessel. When the surface (S) of polycondensate is incessantly renewed so that the S/V value is constantly kept at 0.07 or greater, PDO, even though it is hard to remove due to its characteristic low vapor pressure (see Figure B attached), is efficiently discharged from the polycondensation reaction vessel. In this way the polycondensation can reach a high degree of polymerization (high intrinsic viscosity).

Under a polycondensation reaction satisfying Formula (2), a polymerization reaction proceeds towards formation of a high polymerization product in a short time without occurrence of thermal decomposition. As a result, a polymer with excellent



color can be prepared without the addition of color modifier. In this connection, reference is made to Table A below where data from Examples 1 and 2 (see the specification at page 26, line 1 to page 27, line 6 for Example 1; at page 27, line to 32 for Example 2) are compared with those of Comparative Example 1 (see the specification at page 23, line 32 to page 25, line 5).

Table A

| Reaction               | X value <sup>1)</sup><br>(%) | S/V<br>(cm <sup>2</sup> /g) | [η]<br>(dl/g) | Color                     |         |
|------------------------|------------------------------|-----------------------------|---------------|---------------------------|---------|
|                        |                              |                             |               | L*value                   | b*value |
| Comparative Example 1  | 32                           | 0.05                        | 0.8           | Leveled-off phenomenon    | 87 6.2  |
| Example 1: Small scale | 51                           | 0.17 - 0.24                 | 1.0           | No leveled-off phenomenon | 90 2.1  |
| Example 2              | 58                           | 0.25                        | 1.2           | -                         | 90 2.3  |

X value<sup>1)</sup>: Hydroxyl group content (%) in the whole terminal groups in a polycondensate at the end of polycondensation

In Examples 1 and 2 and Comparative Example 1, the catalysts (esterexchange/polycondensation catalysts; titanium tetrabutoxide/titanium tetabutoxide) were used in the absence of color modifier. In Examples 1 and 2, PTT polymers having a b\* value of less than 5 with an intrinsic viscosity greater than 1.0 are obtained by carrying out the polycondensation reaction while maintaining X values greater than 40 by controlling agitation intensity in terms of S/V value greater than 0.07. In Comparative Example 1, leveling off of intrinsic viscosity at 0.8 dl/g took place producing a PTT with a b\* value of 6.2 and a X value of 32 in which the reaction system is agitated at a S/V value of only 0.05.

Schmidt describes a process for the production of PTT with no more than 5 ppm acrolein and no more than 3 ppm allyl alcohol from terephthalic acid and PDO. Schmidt et al. obtains the PTT by a process satisfying the following conditions (a) to (c):

- (a) Esterification is carried out in the presence of a specific titanium based catalyst;
- (b) After termination of esterification, the etherifying catalyst is deactivated by addition of phosphorous compound; and
- (c) Polycondensation reaction is carried out in the presence of antimony-based catalyst.

Accordingly, the process of Schmidt is a process using a specific combination of a specific esterification catalyst and a specific polycondensation catalyst.

In view of the Examples and Comparative Examples described in Schmidt, it is apparent that that process produces a polymer having maximum possible viscosity of around 0.92 because further polycondensation would reverse it due to decomposition reactions. As a result, the occurrence of yellowish discoloration of the product cannot be avoided unless a suitable amount of coloring agent is present in the precondensation system. Note that in the case where use of an inappropriate amount of cobalt or no use is made in the polycondensation as in Examples 4 and 5 of Schmidt, a yellow tinged PTT polymer having a  $b^*$  value greater than 5 is produced.

Maintaining the S/V value in the range claimed avoids the necessity of using color modifiers to improve the  $b^*$  value. Accordingly, it is submitted for these reasons

also the process claims cannot be considered to be anticipated by or obvious over Schmidt.

Its withdrawal as a ground of rejection of claims 5 and 10 and their dependent claims 7-9, 12, and 14 is requested.

It is believed claims 1, 3-5, 7-10, and 12-14 are in condition for allowance and such action is therefore requested.

Signed copies of the two declarations will be filed in supplement to this Amendment.

Enclosed is a new Abstract on a separate sheet of paper in compliance with M.P.E.P. §608.01(b)

In view of the foregoing amendments and remarks, Applicants respectfully request reconsideration and reexamination of this application and the timely allowance of the pending claims.


Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

FINNEGAN, HENDERSON, FARABOW,  
GARRETT & DUNNER, L.L.P.

Dated: October 22, 2003

By:

  
Arthur S. Garrett  
Reg. No. 20,338

**Attachments:**      **New Abstract**  
                         **Exhibit A (Rule 132 Declaration of Dr. Junichiro Kato - 4 pages)**  
                         **Exhibit B (Rule 132 Declaration of Dr. Junichiro Kato - 3 pages)**  
                         **Two sheets of drawings - Figures A & B**